Free Flight Performance Metrics

What works?

Oct. 11, 2001

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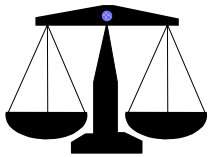
Overview

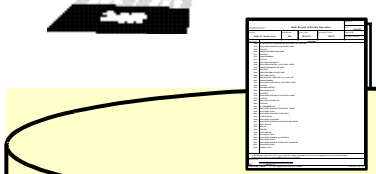
- **Benefits of Performance Measurement**
- **Measuring Free Flight Technologies**
- **What works**
  - **In Terminal Operations – Throughput and Efficiency**
  - **In Enroute Operations – Restriction Removal**
  - **Tool Usage Data**
- **What is difficult**
  - **Safety**
  - **Enroute Throughput and Delay**
  - **Predictability and Flexibility**
- **OEP Metrics Development**

Importance of Performance Measurement

Improved FAA Decision Making



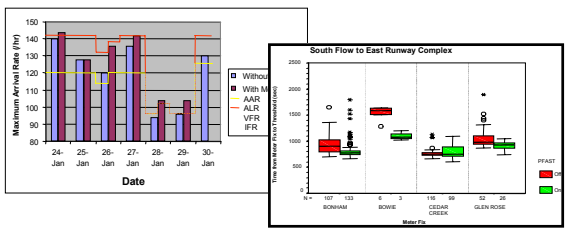
NAS modernization decisions, e.g., FFP2



ATM System Performance Database
(Baseline and Post-implementation data)

Government Mandate (GPRA)

Analyses

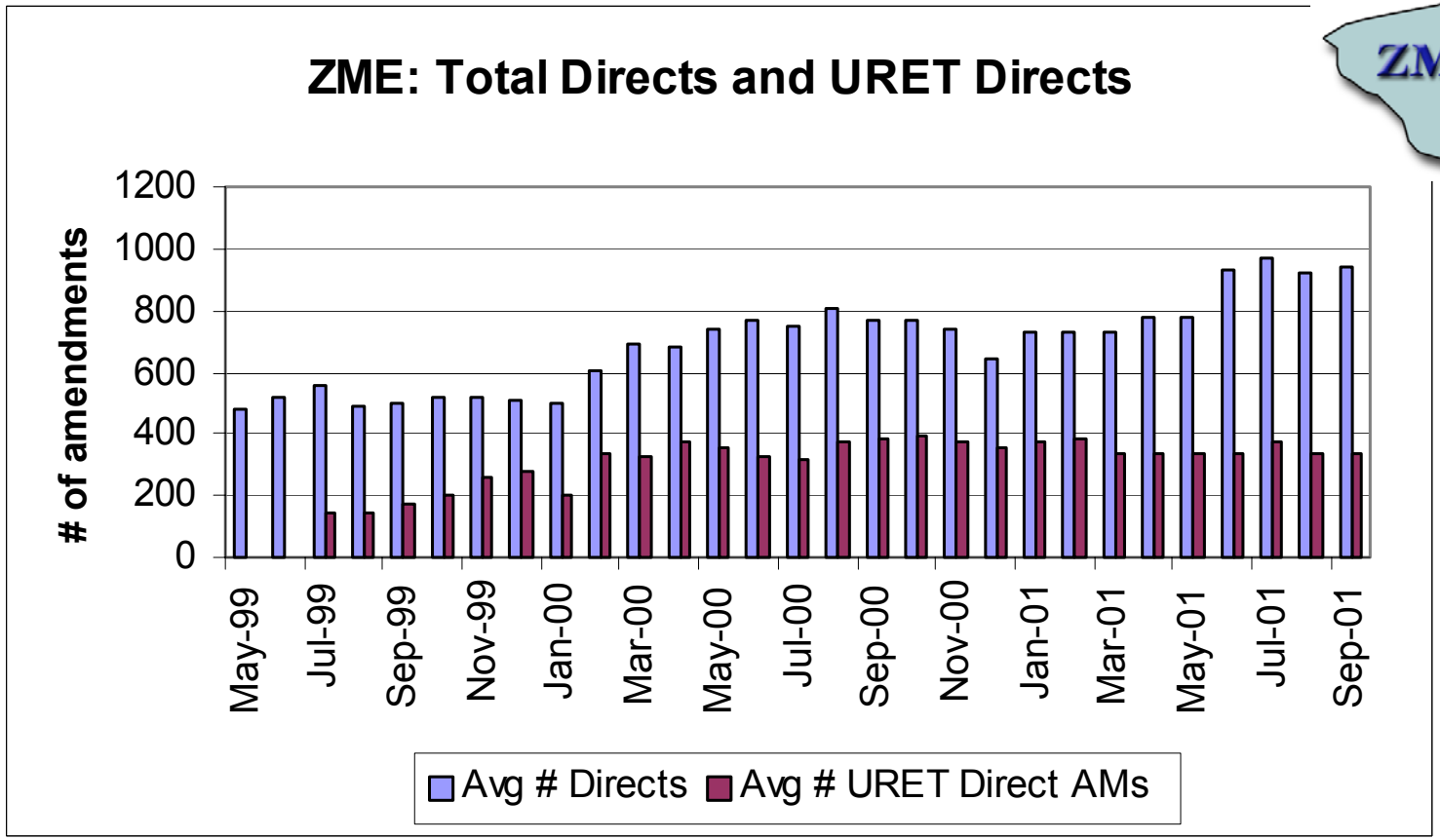


Feedback to FAA facilities

Benefit Mechanisms

- When analyzing performance it is important to confirm that the mechanisms exist for providing the measured benefits:
  - Traffic handled differently than before
  - Improved situational awareness
  - Changes in holding patterns
  - More consistent spacing in arrival flows allow additional departures

URET Directs at ZME



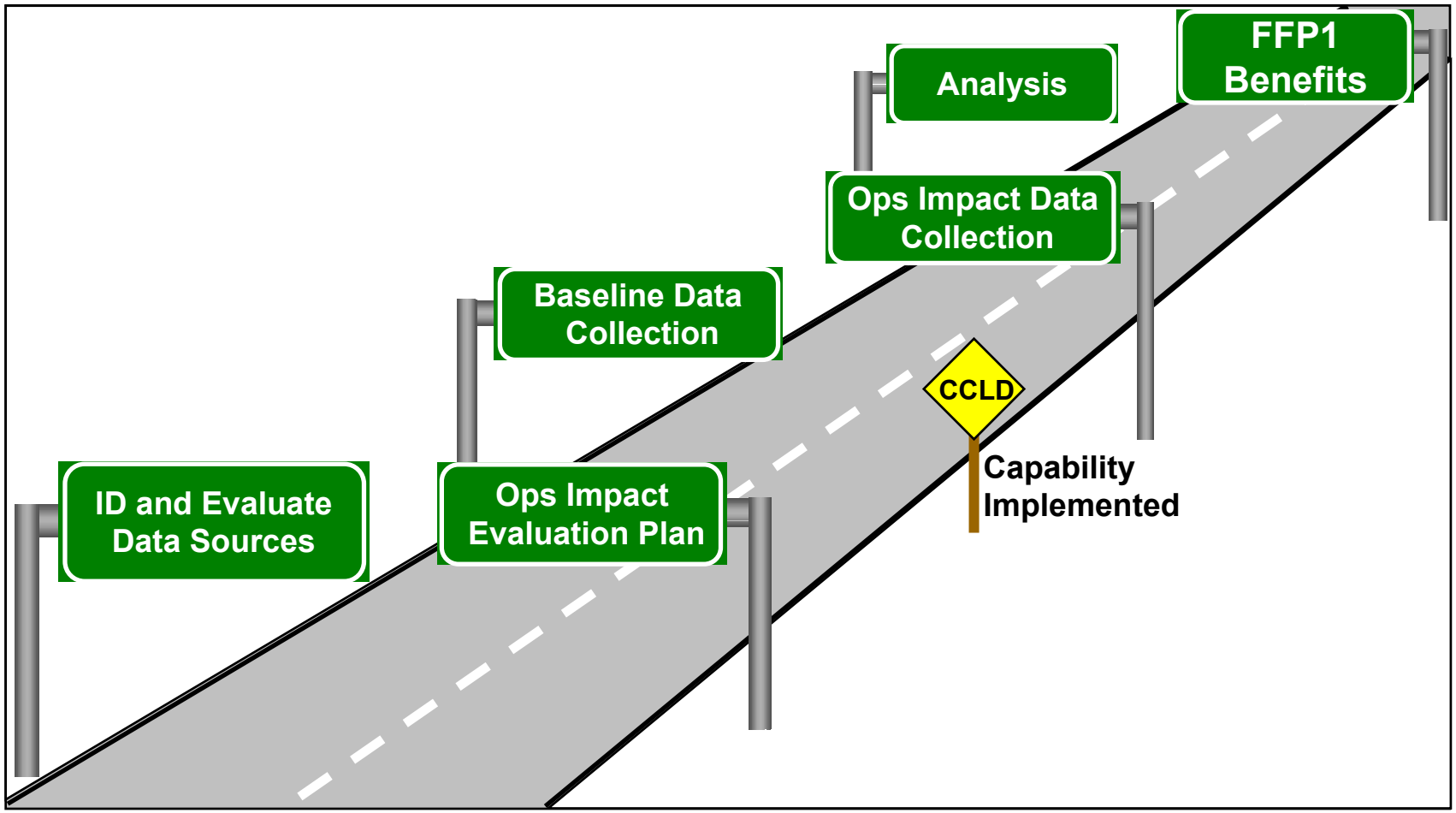
Notes:

- **Data Sampling: 2 days/week; between 14Z and 22Z**
- **URET 2-way processing began in July 99**
- **Includes any Lateral Amendment processed by Host**

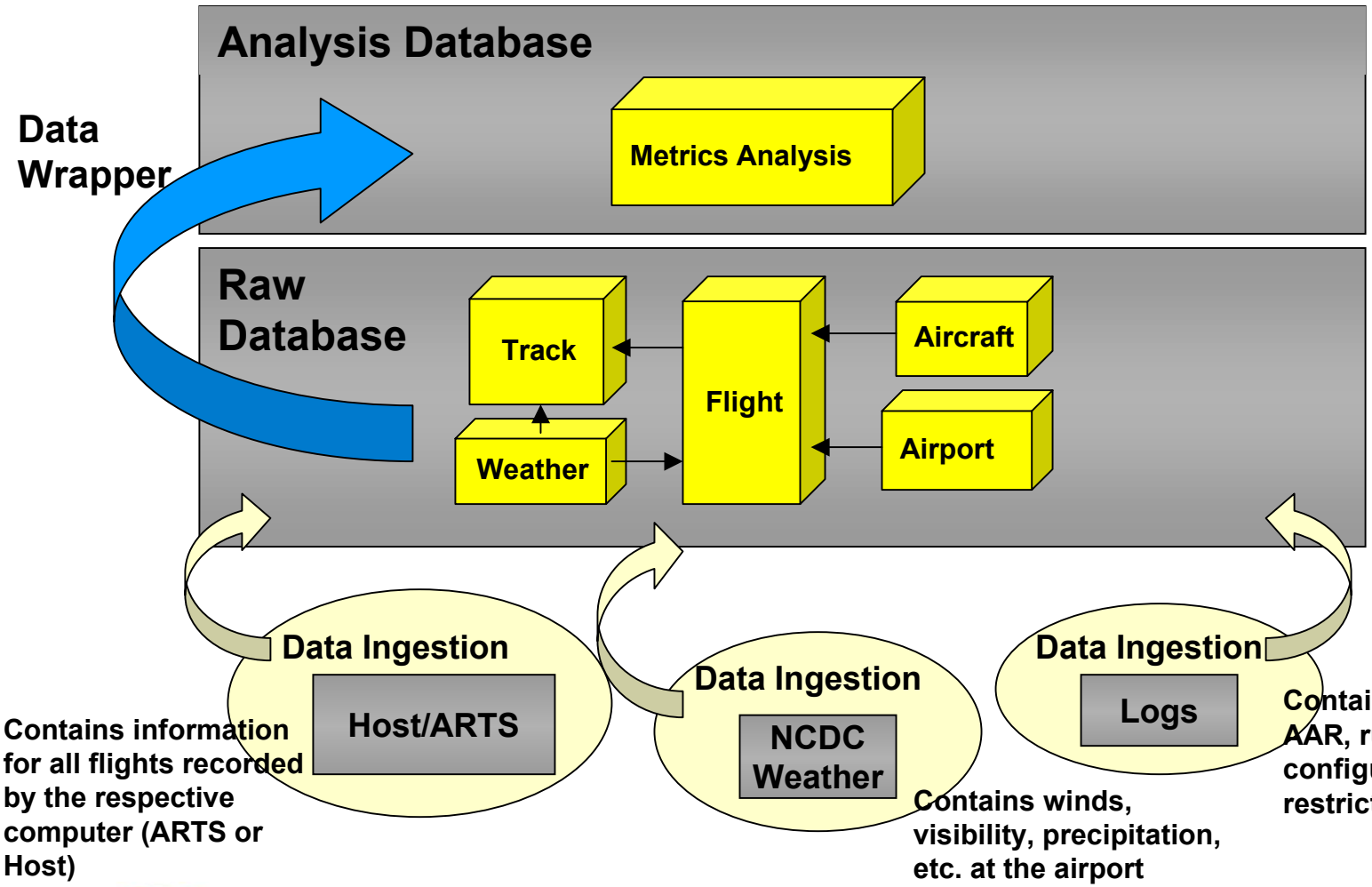
Focus on Performance Metrics

- **What are performance metrics?**
  - ***Customer driven*** **quantitative measures of operational performance**
    - **Safety**
    - ★ ***Capacity***
    - ★ ***Delay/Efficiency***
    - **Predictability & Flexibility**
    - **System Productivity**

FFP1 Ops Impact Evaluation Roadmap



Database Overview



FFP Metrics – Lessons Learned/What works

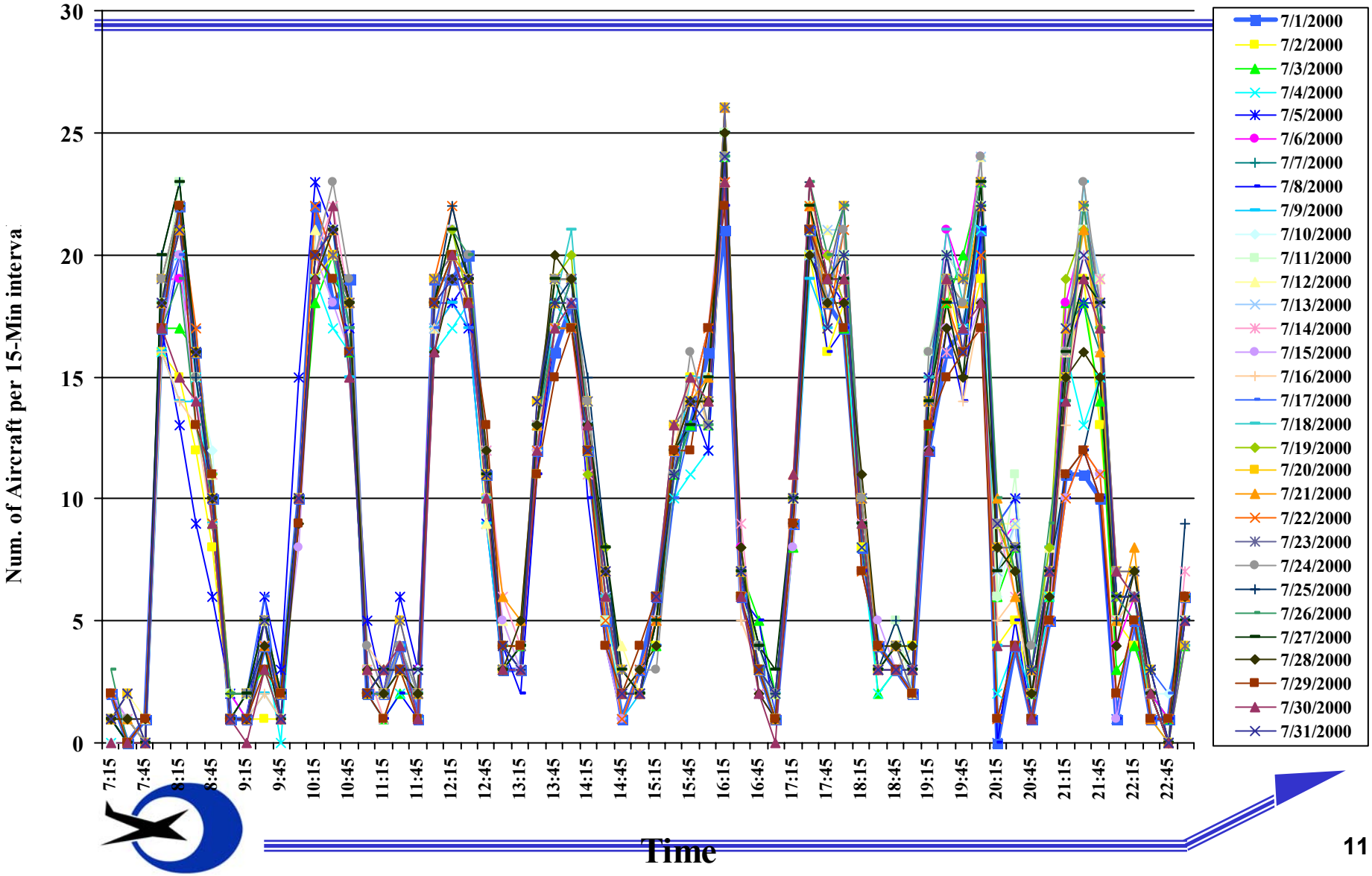
- **Terminal Area Performance Changes are measurable:**
  - **Increased throughput during peaks indicates increased capacity**
  - **Clear Objective Functions: Increased throughput, decreased flight times**
  - **Normalization achievable (demand, conditions, etc.)**
  - **Automated analyses possible**

Analyzing Peak Terminal Throughput

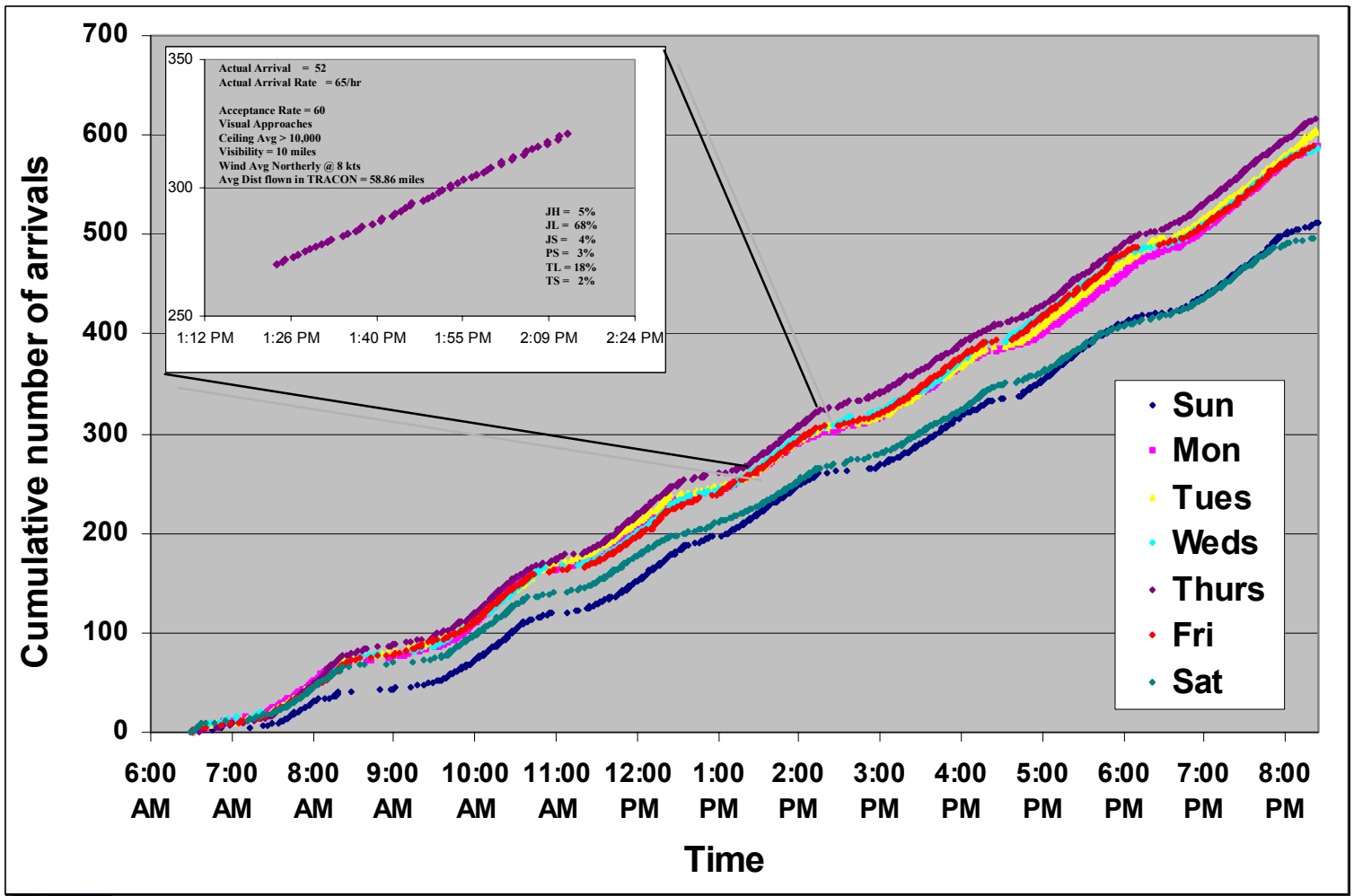
- ***Focus on peaks where throughput is constrained by capacity***
  - ***During slow traffic periods, there is little or no benefit with new tools***
- **Determine when system is stressed**
  - **Demand exceeds capacity**
  - **Desire to measure throughput not constrained by demand**
- **Determine criteria for minimum peak period**
  - **May depend on site**

MSP Actual Arrival Peak-Times

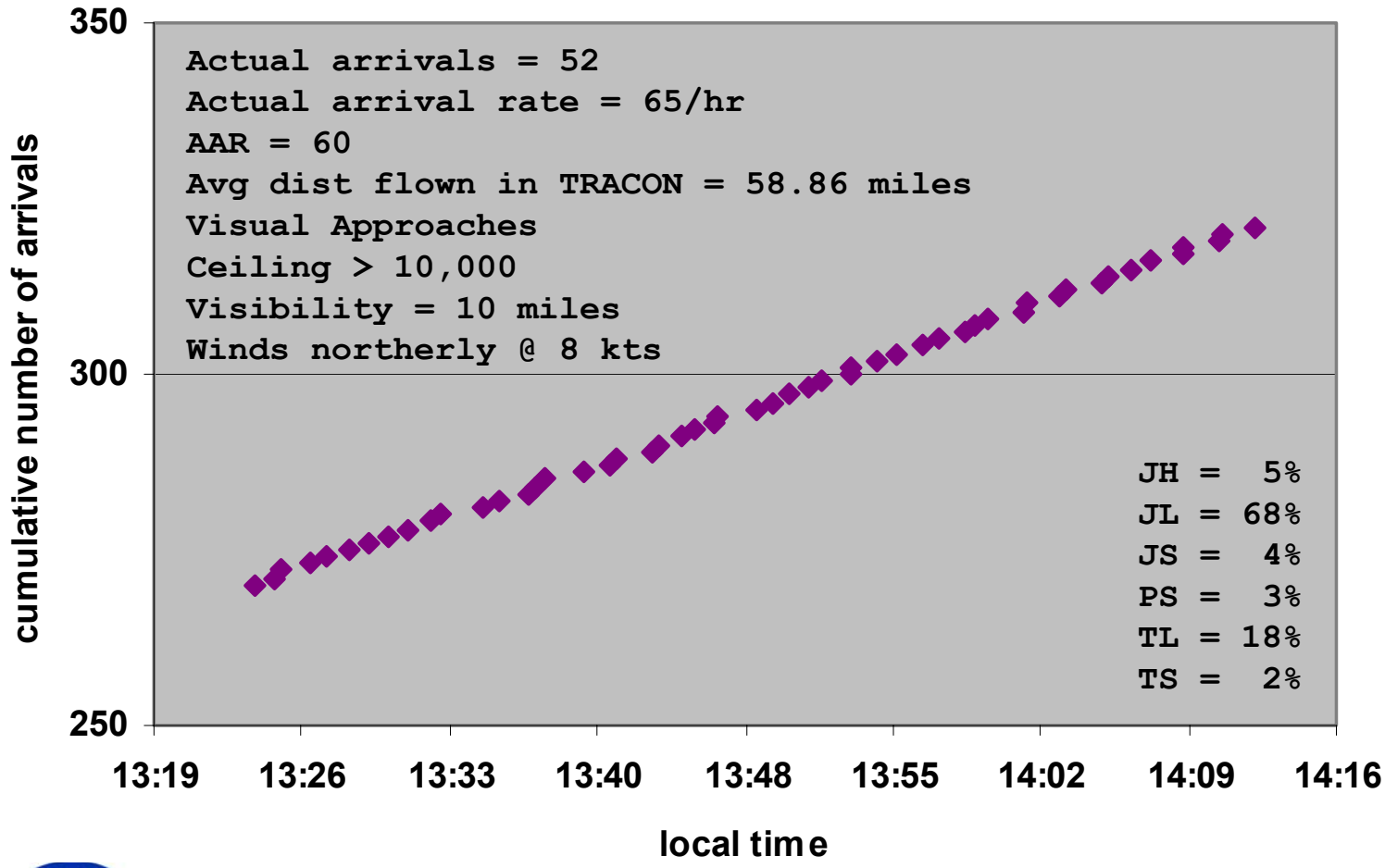
(July 2000)



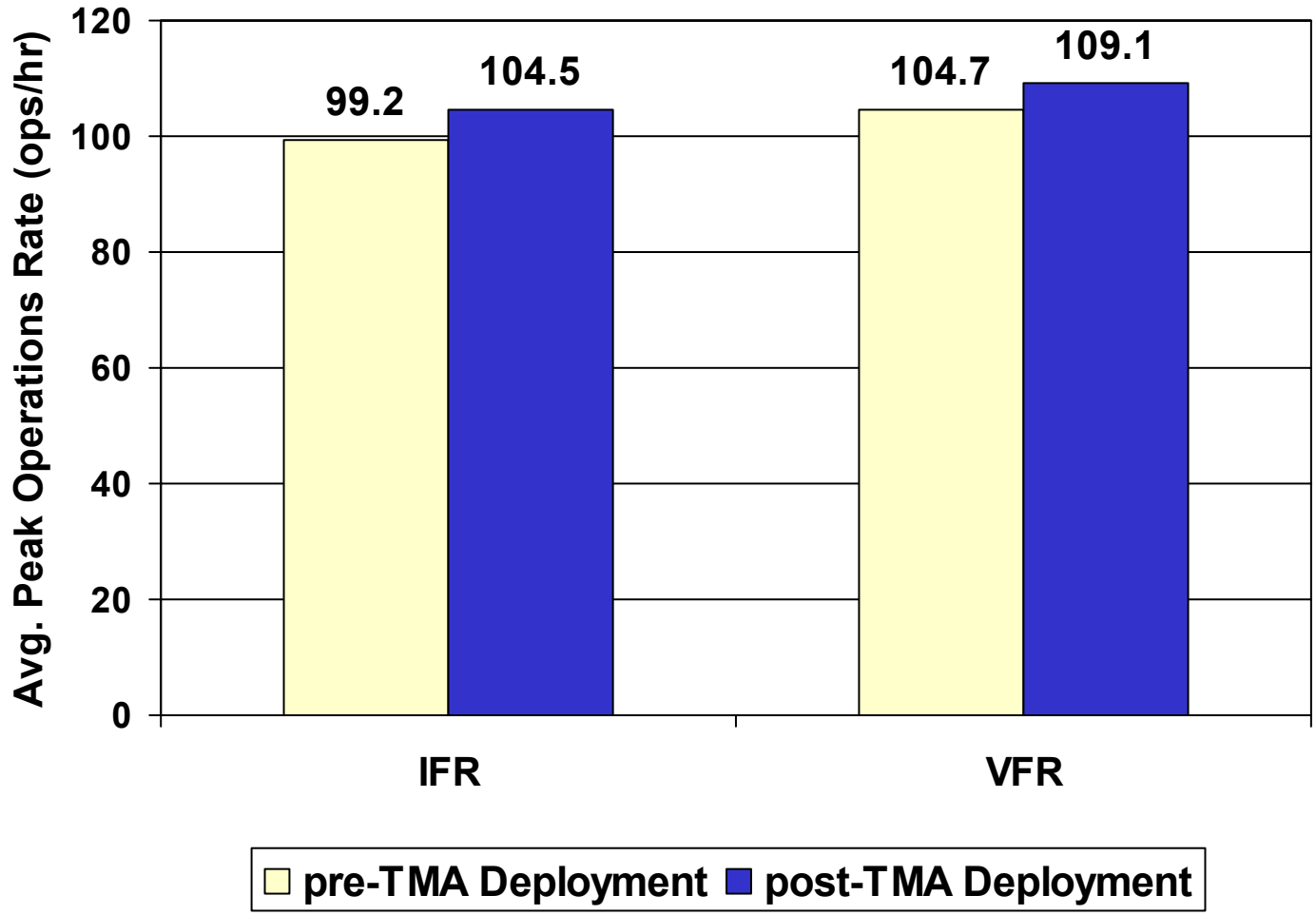
MSP Daily Cumulative Arrivals
12-18 March 2000



MSP Peak Period Cumulative Arrivals
16 March 2000



TMA at ZMP/MSP



Efficiency Measures

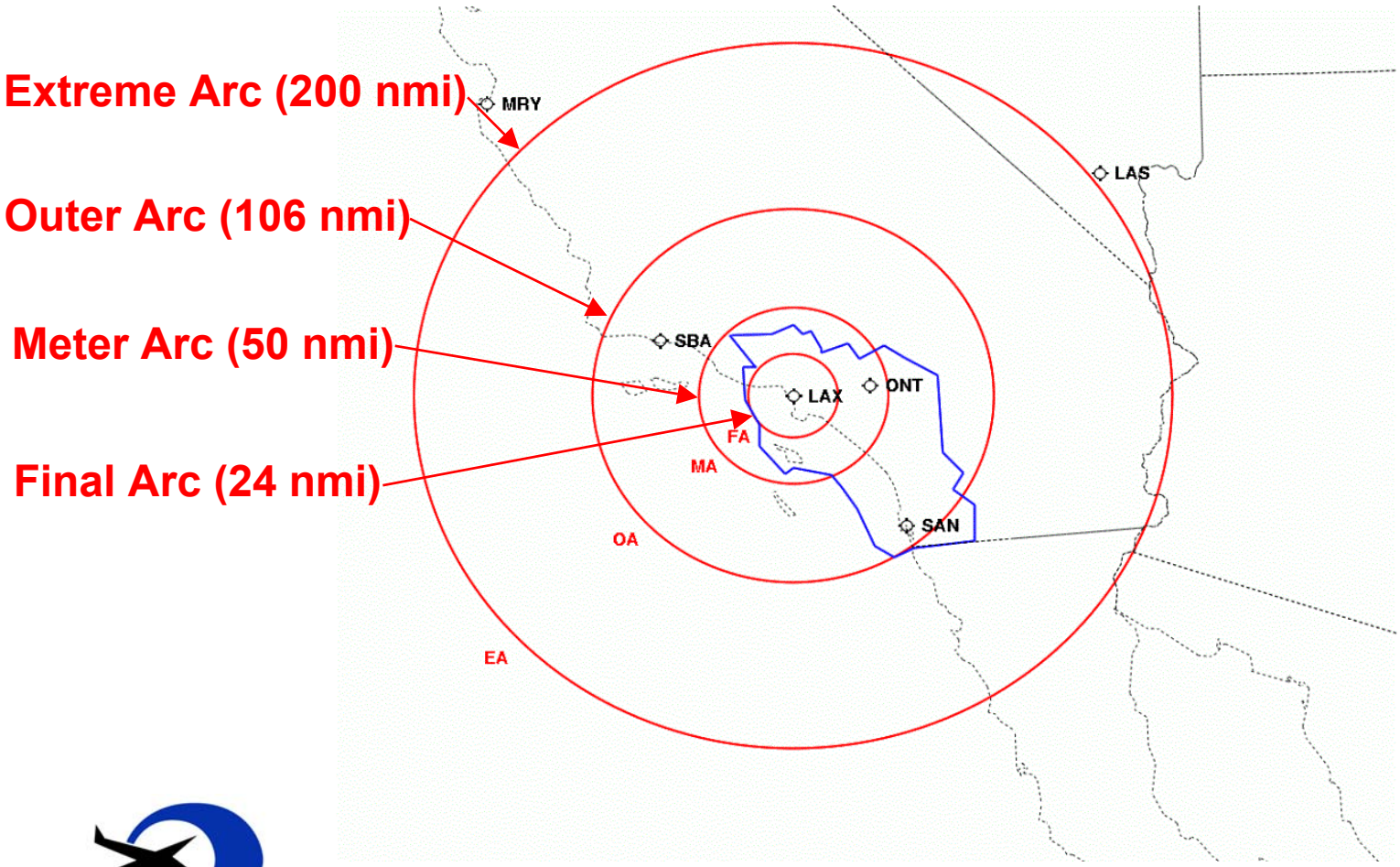
- **Flight altitude efficiency measurable:**
  - **Delay distribution**
  - **Capturing Static Restriction removal**
  - **Flight time/distance changes**
  - **Changes in holding**

Metering: Analyzing Delay Distribution

- **Looking for shift of "delay" to higher altitudes (further from TRACON) – CTAS Enroute**
  - **Continued focus on peak periods**
  - **Normalize for demand**
  - **Combine delay distribution with throughput results**
- **Use Series of Arcs around TRACON**
- **Consider impact on internal departures**

SCT/LAX Airspace

To examine holding we found flying times and distances between rings around LAX



SCT/LAX Flying Distance Analysis

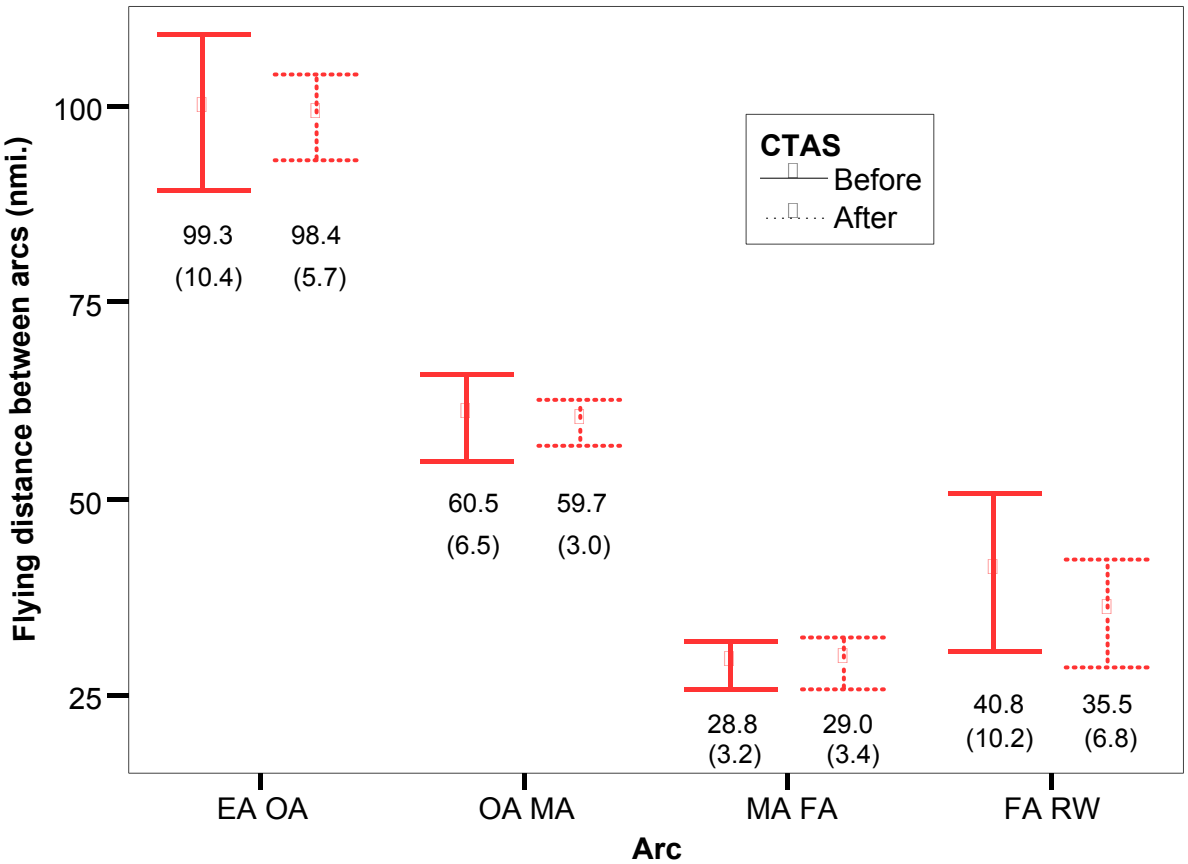
After CTAS: **the distance between final arc and runway ~5 nmi less**

the standard deviation is less indicating a smoother flow

LAX

(2/00-3/01)

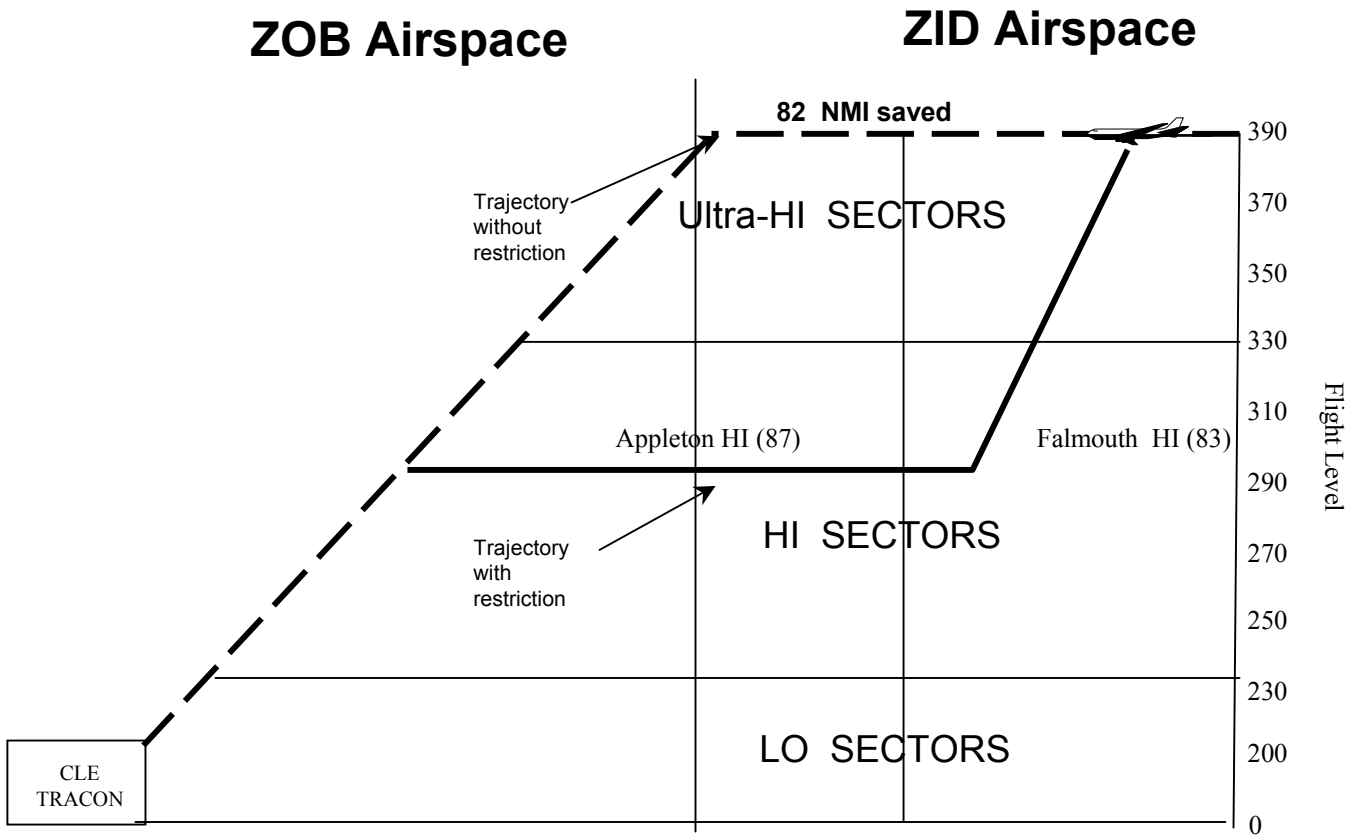
For times when Arrival Demand>AAR



Removing Static Restrictions

- **URET supports removal of static altitude restrictions**
  - **Automatic conflict detection for Controllers**
  - **Move to separating aircraft from aircraft**
  - **Move away from separating aircraft from airspace**
- **Facilities engage with Users on route/restriction priorities**
- **Benefit to users by allowing aircraft in transition to stay higher longer**

Example: Lifting of Restrictions



Removed November 2000: CLE arrivals 83/87 at FL290

Altitude Restriction Removal

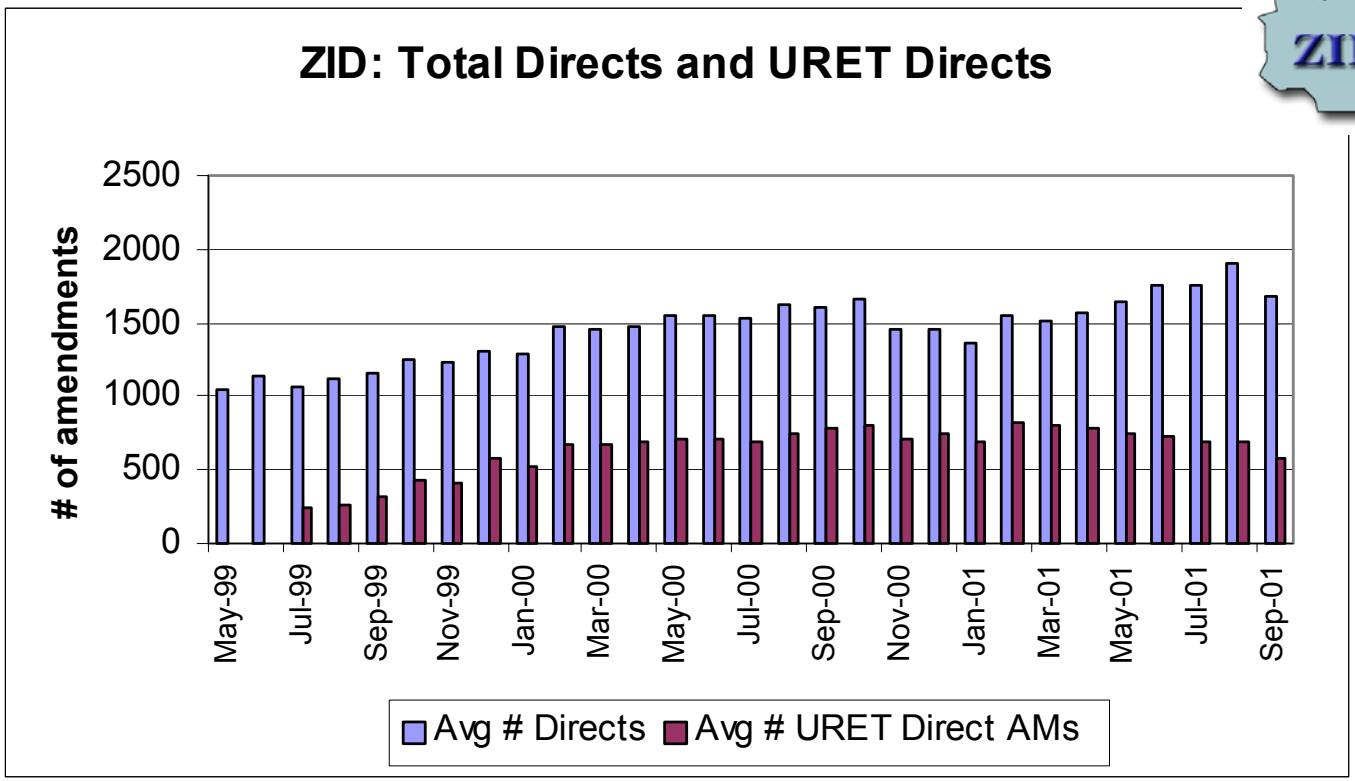
- **ZID Intra-facility restrictions removed**
  - **19 restrictions removed; 1 being evaluated**
  - **Savings to users approximately $950,000 annually**

History of Static Altitude Restriction Removal - ZID		
Restrictions Lifted or Modified	**Estimated Annual Fuel Savings**	**Estimated Annual Savings @1.00 per gal.**
April – November 2000 6 Restrictions	234,350	$234,350.00
March – April 2001 13 Restrictions	770,885	$770,885.00
Plan to Lift May – June 2001 1 Restriction	23,716	$23,716.00
Estimated Annual Savings	958,951 gal.	$958,951.00

Usage Data

- **Collecting "usage" data for tools a must**
  - **May require software within tool to collect**
  - **Provides link from tool to operational change**
- **Tool usage information can indicate "value" of the tool to the TMC's and controllers**
  - **Is the tool being used?**
  - **Are the advisories followed?**

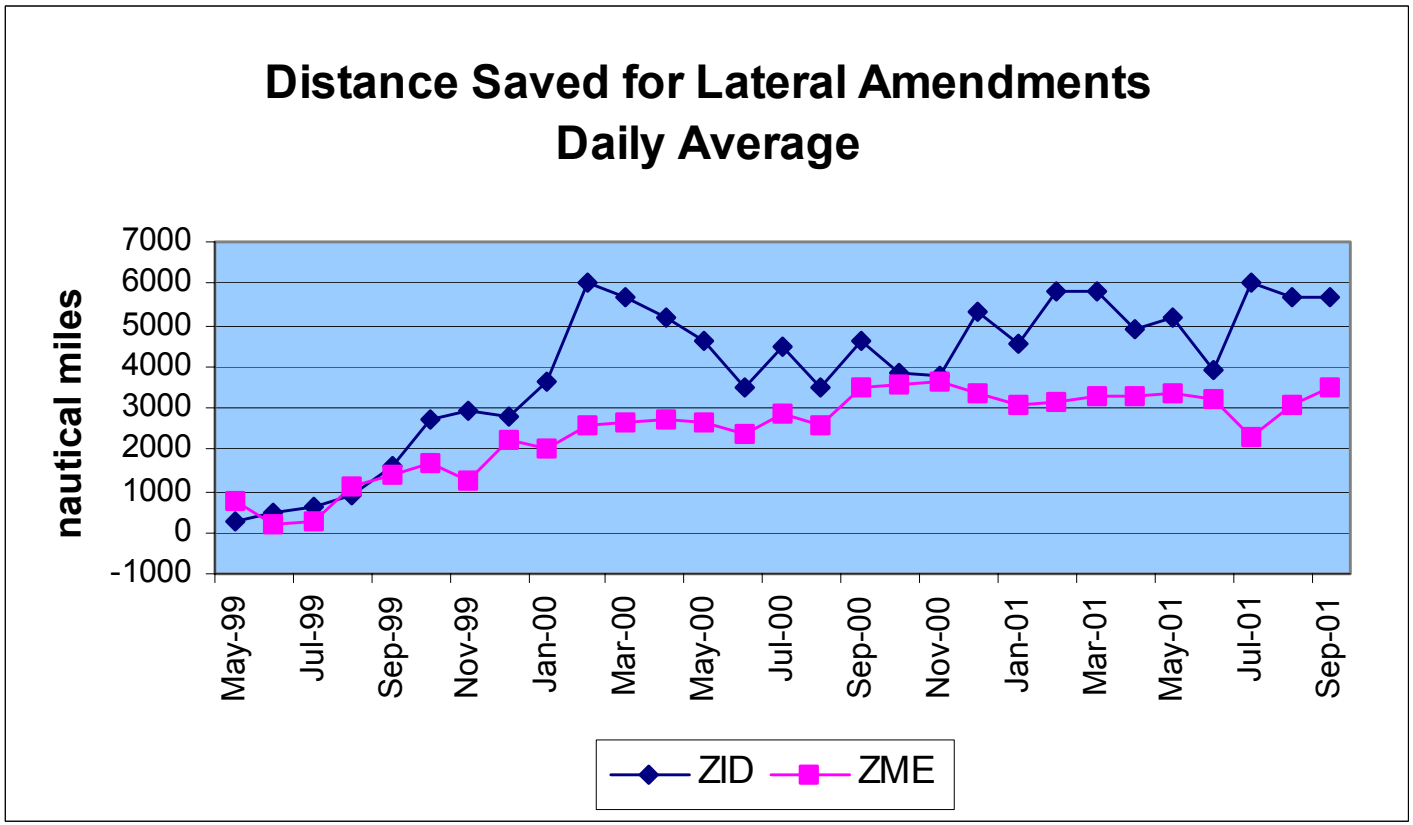
URET Directs at ZID



Notes:

- **Direct Data Sampling: 2 days/week; between 13Z and 23Z**
- **URET 2-way processing began in July 99**
- **Includes any Lateral Amendment processed by Host**

Distance Savings for Lateral Amendments



Notes:
- **Data Sampling: 2 days/week**
- **ZID between 13Z and 23Z; ZME between 14Z and 22Z**
- **URET 2-way processing began in July 99**
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Data through 25 Feb 01

ZID: September 01 Average TPs, Amendments, and Tracked Aircraft Count

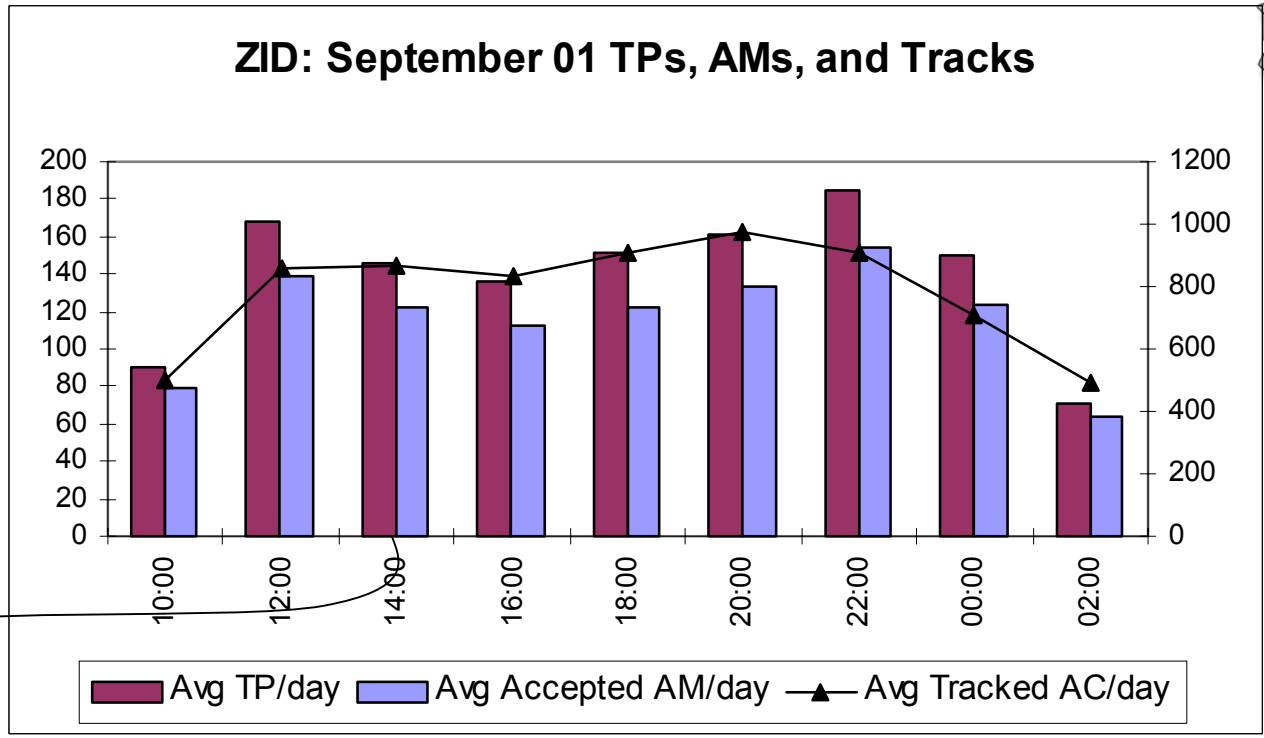


Chart Interpretation

- For the entire ZID center, between 14Z and 16Z on days when URET was running; for the whole month of September, there were on average 146 TPs made per day, on average 122 of these TPs were amendments accepted by the Host. During that same 2 hour interval, on average there were 868 tracked flights in the center.
- URET hours: 146 hrs/wk

Data through 26 September 01

What's difficult….

- En Route Throughput
  - How to best measure?
    - Center throughput @ peak periods
    - Sector throughput @ peak periods
    - "Route" throughput @ peak periods
    - City Pair throughput @ peal periods

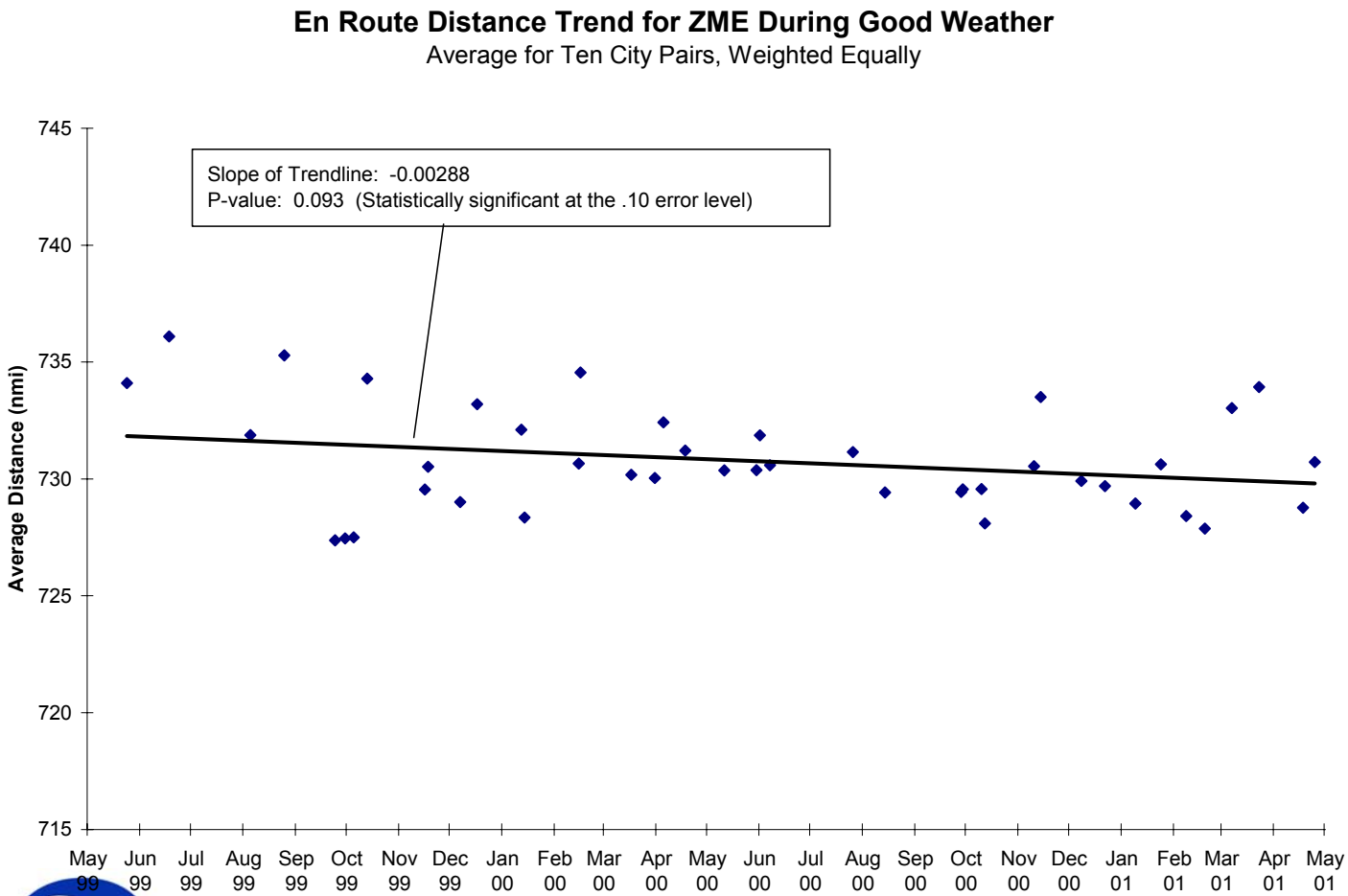
- En Route Efficiency (time & distance)
  - Normalizing for demand
  - Normalizing for wind

- En Route Improvements during bad weather
  - How to make comparable?

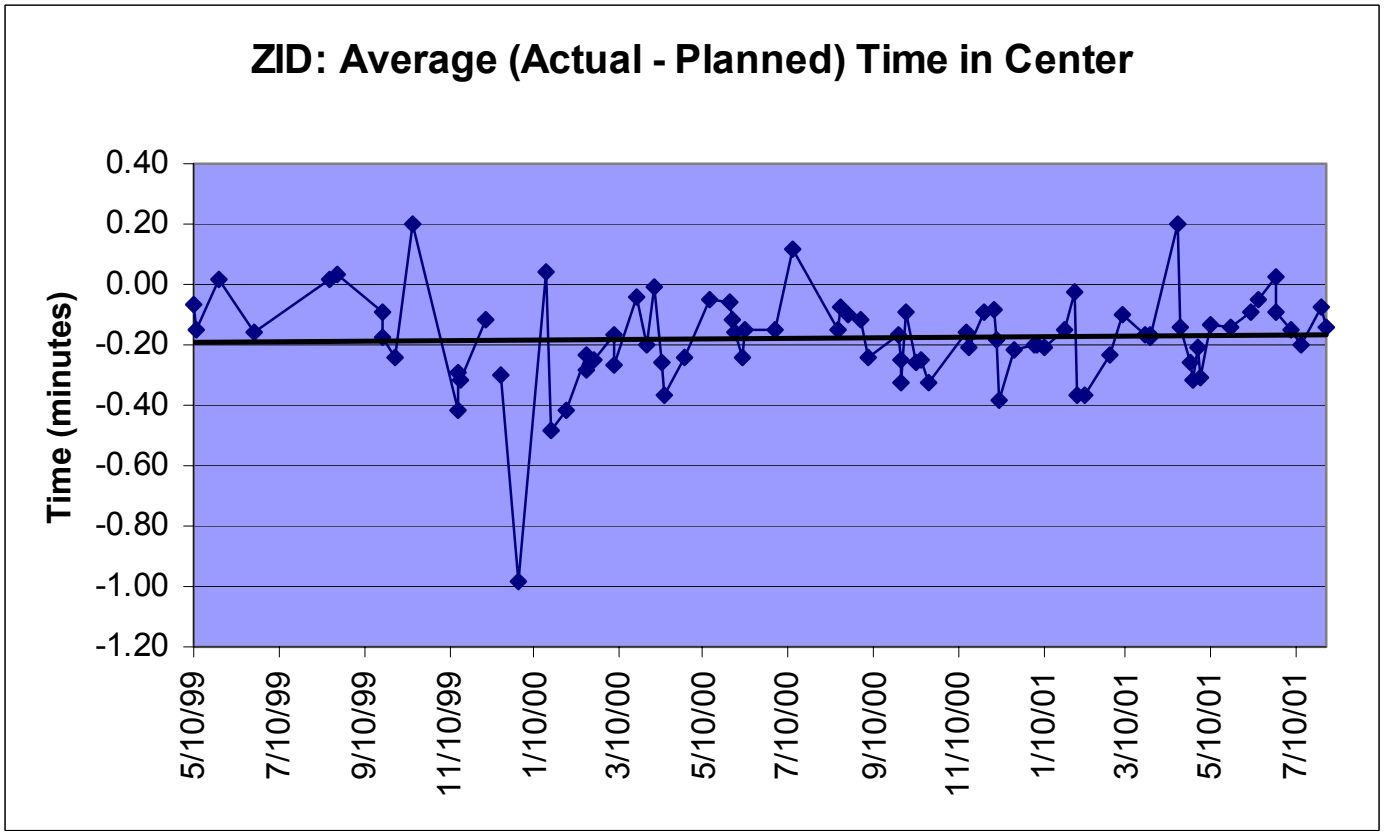
En Route Time & Distance Measurement

- **Objection Function Not Consistent**
  - **Minimum time and/or distance must be assumed on aggregate level**
- **Results contain high level of noise**
  - **Trends may be masked**
- **Difficult to develop conclusive analyses**
  - **Analyze a variety of measures**

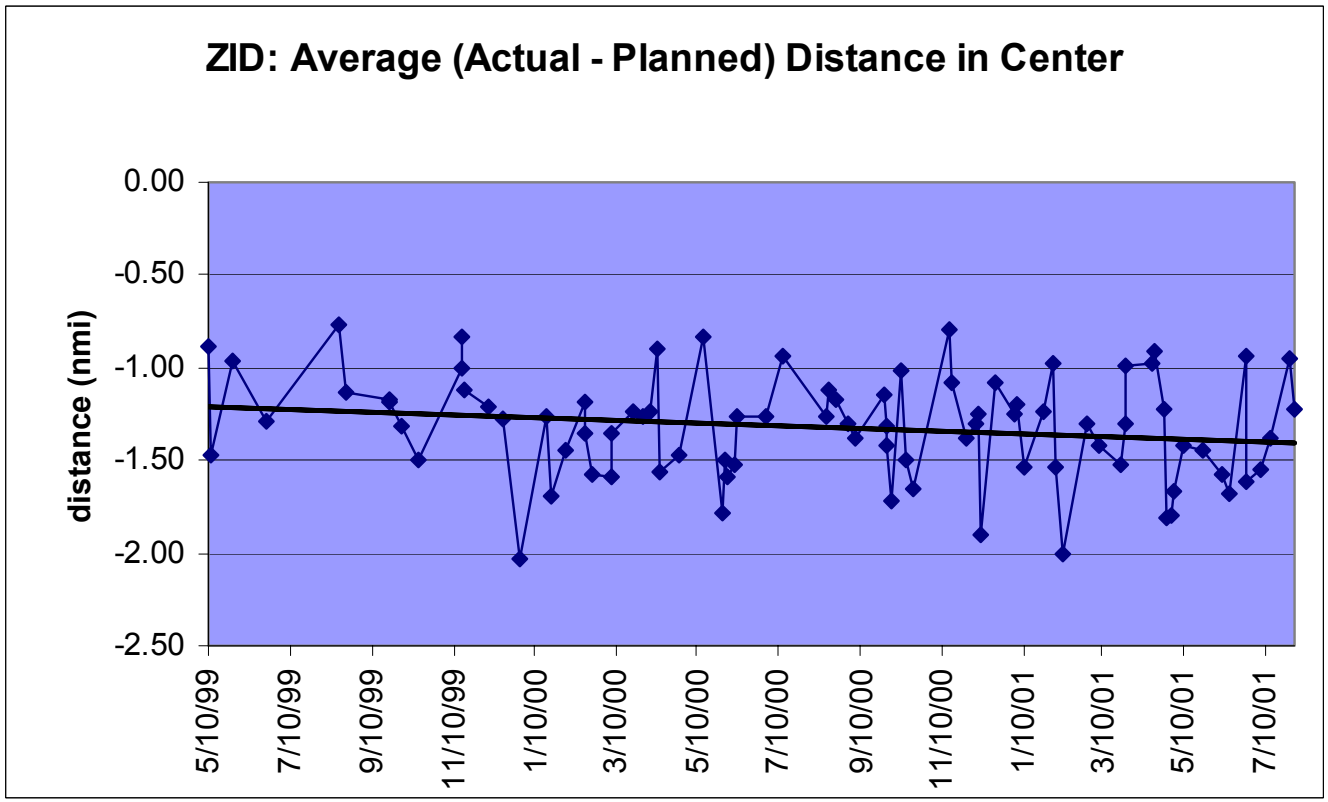
EnRoute Distance



Actual-Planned Time in Center



Actual-Planned Distance in Center



Future : Additional Data Points - Diagram